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ABSTRACT

This study was designed to identify whether advanced nonnative speakers of English rely on recurrent sequences to produce fluent speech in conformance with neural network theories and symbolic network theories; participants were 6 advanced, speaking and listening university students, aged 18-37 years (their native countries being Korea, Japan, Taiwan, Hong Kong, and the People's Republic of China). Subjects' introspections on how their words come to mind in relation to speech production are also investigated. Subjects were taped repeatedly while practicing speeches on familiar and newly learned topics; they were interviewed, and they completed questionnaires on background and speech preparation strategies. Results indicated that a mean of 66.4% used recurrent sequences (RSs) that were consistent across topics and tellings as predicted by semantic and neural network theories and that all subjects reported use of partial phrases, phrases, or strings of phrases; subjects who approached the task as if memorizing a script or piano piece, used immediate repetition of RSs and lengthy RSs. Findings confirm that recurrent speeches are an essential element of planning and executing speeches in real time by advanced nonnative English-speakers. (Contains 44 references, 1 figure, and 9 tables.) (NAV)

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Cognitive Processes Underlying
Nonnative Speech Production:
The Significance of Recurrent Sequences

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Abstract

This study was designed to identify whether advanced nonnative speakers of English rely on recurrent sequences to produce fluent speech in conformance with neural network theories and symbolic network theories. In addition, it investigates whether subjects' introspections about how their words come to mind are consistent with their speech production

Subjects were taped repeatedly while practicing speeches on familiar and newly learned topics. They were interviewed, and completed questionnaires about their backgrounds and speech preparation strategies.

Findings indicate that (a) a mean of 66.40% of the subjects' speeches are comprised of recurrent sequences (RSs). Recurrent sequences are defined as linguistic material longer than a word that are repeated verbatim. (b) The subjects' proportions of RSs are consistent across topics and tellings as predicted by semantic and neural network theories. (c) All subjects report that partial phrases, phrases, or strings of phrases come to mind. This is consistent with their reliance on recurrent sequences. Those subjects that approach the task as if memorizing a script or a piano piece, use immediate repetition of RSs, and lengthy RSs. These findings support that recurrent sequences are an essential element of planning and executing speeches in real time by advanced nonnative English-speakers.

Introduction

There are two types of network theories that model how nonnative speakers (NNS) produce fluent speech in real time by using recurrent sequences. Recurrent sequences are operationally defined as recurrent stretches of linguistic material longer than a word (Schmidt, 1993). Neural network theories such as Instance Theory and Strength Theories provide neurophysiological models of the neural processes underlying fluency. Similarly, Semantic network theories such as Hierarchical Chunking Theory provide a model to investigate the cognitive processes underlying fluent speech production.

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At the same time, when investigating fluent speech production, context plays an integral role. Pursuant to the social construction paradigm, to be considered fluent, one must be able to produce the appropriate thing to say, in a wide variety of contexts, in real time. These criteria emphasize that speech production is not bound by the individual brain. Rather, speech production is a social phenomena in which the context is an integral aspect of the cognitive activity, not just a back drop for it (Bruner, 1981, 1986; Grice, 1975; Nattinger and DeCarrico, 1992).

Accordingly, this study observes advanced nonnative speakers practicing and delivering short speeches in the classroom. This task is naturalistic and commonly performed by nonnative English-speaking professors, teaching assistants, and international students in U.S. university settings. This context will reveal how nonnative English-speakers deal with the social demands of classroom lecturing in real time. Once the data is gathered and analyzed, it may reveal whether any of the network based theories help to explain how nonnative English speakers use recurrent sequences to produce fluent speech, and facilitate listeners' aural cognition.

Instance Theory

According to Logan's (1988) Instance Theory, novices begin with a general algorithm or phrase for communication purposes represented at the neural level as a network of synaptic connections. As speakers gain experience, they use specific phrases to address specific issues. Using established neural networks, these same algorithms are retrieved when speakers encounter the same issues (Logan, 1988, p.493). Instance Theory has been applied in the ESL context by Robinson and Ha (1993) who found that ESL students exhibit faster reaction times to previously seen sentences than novel instances when making grammaticality judgments.

Applying Instance Theory to speech production, one would expect that the first time nonnative English-speakers give a speech, they construct some of their phrases anew. However, upon repetition of the speeches, they will use a more efficient single-step construction process employing prefabricated sequences.

Instance Theory suggests that morphological rules are not manipulated in the production of morphologically complex words unless the words are first-time creations or have been produced so infrequently that memory traces are

insufficient for direct retrieval. Instance theory also suggests that the retrieval of past solutions from memory may include complex forms at higher levels than the word, including phrases and both completely formulaic and partly open clause structures. Applied linguists posit that if memory is the basis of fluency, the conventional wisdom regarding the status of formulaic speech as a peripheral phenomenon in L2 speech production is therefore in serious need of revision (Schmidt, 1993, p.371).

Strength Theories

Strength Theories hold that memory traces are organized for production in multiple neural networks of shared representations (Gasser, 1990). They emphasize strengthening the connections between stimuli and responses to facilitate knowledge transfer. Connectionist models are congruent with the ill-structured domain of speech production. An ill-structured domain is one which requires "multiple interconnectedness between different aspects of domain knowledge, multi-dimensional or multi-perspectival representation of examples and allowance for various forms of naturally occurring complexity and irregularity" (Spiro, Vispoel, Shmitz, Samarapungavan, Boerger, 1987). In sharp contrast with Instance Theory, Strength Theories suggest that the speaker assembles situation-sensitive schemata from knowledge fragments. They suggest that the production of a phrase does not rely on the specific activation of a specific neural network. McKay (1982) finds that fluency and flexibility are positively correlated, and that increased practice leads to increased transfer. Practice strengthens the connections in syntactic, lexical, phonemic, propositional, and conceptual networks.

In fact, Strayer and Buckley's, studies (1990) reveal that subjects are able to perform memory search tasks beyond the instances encountered during training. This demonstrates that Instance Theory alone is insufficient to explain the pervasive occurrence of transfer. Nonetheless, Instance Theory does account for faster response times and increased accuracy for well-practiced examples in comparison to less practiced items.

Hierarchical Chunking Theory

Perhaps the most robust model for explaining speech production is the Hierarchical Chunking Theory (HCT) based on semantic networks. Servan-Shreiber and Anderson's (1990) study demonstrates that learning acceptable strings of words of an artificial language can be accomplished by exposure to

exemplar sentences. They find that acceptability judgments are based on prior exposure to a collection of learned linguistic sequences linked by goal settings. The study also demonstrates that it is not necessary for the subjects to abstract the underlying rules of the system to make acceptability judgments as posited by linguistically based theories of speech production (Chomsky, 1980; Dell, 1986; Levelt, 1989; Pinker, 1991).

Drawing on the artificial intelligence research of Rosenbloom and Newell (1987), Schmidt (1993) suggests that a hierarchical chunking model is appropriate for modeling speech production in which an utterance may consist of previously constructed utterances that fill slots within a larger discourse pattern or when prefabricated chunks themselves have open slots. Likewise, Pawley and Syder (1983) write that, "memorized sentences and phrases are the normal building blocks of fluent spoken discourse and at the same time, that they provide models for the creation of many (partly) new sequences which are memorable and in their turn enter the stock of familiar usages" (p.208). Even nonnative phrases, often considered the best evidence for rule-based productivity, may be stored and retrieved as wholes by nonnative speakers as evidenced by nonnative speakers' fossilized idiosyncratic speech. Dechert (1983) proposes that learners develop lexicalized "islands of reliability" that become the basis for the search processes necessary in the course of planning and executing speech in real time. Fluency depends on stored chunks (Nattinger & DeCarrico, 1992; Raupach, 1984).

The Hierachical Chunking Theory also provides a unified mechanism whereby speakers can use the same mechanism for both speech production and comprehension. Since the goal of spoken discourse is for the listener to construct the speaker's intended meaning, it is necessary for the listener's prior knowledge to be organized in a hierarchy of prefabricated sequences that is consistent with the speaker's hierarchical knowledge organization. Where the interlocutors do not share common collocations, they may use the lower tiers of their hierarchical organizations consisting of shorter sequences. However, where the interlocutors belong to the same discourse community, they may be able to match lengthy prefabricated sequences thereby speeding up comprehension and meaning construction.

Notwithstanding all of the theorizing about the psychological processes that underlie nonnative speaker production, second language (L2)

performance studies using realistic tasks are rare and often aimed at children's second language acquisition (Bates, Bretherton, & Snyder, 1988; Hakuta, 1974, 1987; Huang and Hatch, 1978; Rescorla and Okuda, 1987; Snow, Cancino, Gonzaliz, and Shriberg, 1989; Vihman, 1982; Wong Fillmore, 1979) .

There have been two performance studies in which researchers remark that advanced nonnative speakers rely on idiosyncratic formulae for speech production (Bolander, 1989; Raupach, 1984) In addition, introspective studies by researchers observing their own L2 speech production emphasize the importance of prefabricated sequences for fluent production (Brown, 1973; Barber, 1980; Ferguson, 1976).

Other psycholinguists hypothesize that prefabricated sequences are necessary for fluency and automaticity (Arevart and Nation, 1991; De Bot, 1992; Dechert, 1983; Gabonton and Segalowitz, 1988; Logan, 1988; Pawley and Syder, 1983; Nattinger & DeCarrico, 1992; Peters, 1983; Raupach, 1987; Rumelhart, 1990; Schmidt, 1983, 1993; Servan-Schreiber and Anderson, 1990; Whitaker, 1979). De Bot (1992) explains that first and second language speech production may rely on recurrent sequences accessed from memory because "the average rate of speech is 150 words per minute with peak rates of about 300 words per minute. This means that we have about 200-400 milliseconds to choose each word when Speaking" (De Bot, 1992, p.11). Moreover, since adults' productive first language lexicon consists of more than 30, 000 words when speaking, we must make the correct choice of words one to five times per second. Even so, we make the correct selections 99.9% of the time. Consequently, De Bot (1992) concludes that the basic units of articulatory execution are not syllables as Levelt (1989) claimed or even words, but instead, they are articulatory patterns consisting of syllable strings or, in other words, prefabricated chunks.

Notwithstanding such an interesting hypothesis, no researchers have actually counted what proportion of fluent speech is actually comprised of recurrent sequences. Thus, this study seeks to explore whether recurrent sequences are used by advanced nonnative speakers when practicing and delivering lectures in naturalistic classroom contexts.

Methodological Issues

Since this study is designed to discover what proportion of nonnative speaker production is comprised of recurrent sequences, it is necessary to

define recurrent sequences of speech operationally. The operational definition used is recurrent stretches of linguistic material longer than a word (Schmidt, 1993). By quantifying the proportion of speech production consisting of recurrent sequences (RSs), it will reveal whether recurrent sequences play an important role in nonnative speech production. This operational definition creates a consistent, low-inference, nonsubjective method to quantify the proportion of recurrent sequences within each speech. The percentage of recurrent sequences can be confirmed by different raters because the proportion relies solely on counting the words comprising the recurrent sequences in a speech.

One possible disadvantage of using such a mechanical approach is that community-wide formulas might be excluded if they are not repeated. Another disadvantage is that recurrent sequences that form a frame (e.g. Let it go; Let them go; Let him go.) will be excluded because no two words are repeated sequentially. Another potential disadvantage associated with this operational definition is that it may include repeated sequences that are not semantically united. Some words that follow each other, such as the last word of one utterance and the first word of the next, may coincidentally be repeated in another sequence. These non-semantically bound sequences will be counted as recurrent sequences even if they do not fit our traditional notion of semantically related phrases.

These shortcomings are minimized in this study by having the speakers repeat their speeches. If the subject is using community-wide formulas, it is likely that she will repeat the prefabricated chunk either within one telling or in the re-telling (Arevart and Nation, 1991; Raupach, 1984). Likewise, if certain words are observed to follow each other, even if they do not conform to our traditional semantic notion of a phrase as a stretch of speech associated with a specific meaning that is stored and produced as a chunk, these recurrent sequences should still be included for further investigation.

In sum, by counting the words appearing in recurrent sequences of linguistic material longer than one word in re-tellings of a speech, this quantifiable definition will permit analysis of how great a role recurrent sequences play in nonnative speech production mechanisms. Equally important, if some subjects use recurrent sequences in qualitatively different

ways, the data will allow us to explore individual differences in nonnative speech production in a natural setting.

To calculate each subject's proportion of recurrent sequences per speech, the number of words that were repeated verbatim is divided by the total number of words in the speech. To count the total number of words, only the non-lexical pause fillers "uh" and "um" are excluded. To calculate the number of words in a recurrent sequence, some utterances from a subject's transcript are offered:

(1) My weakest processing mechanism is the linguistic processing mechanism.

(2) My weakest point is knowing which words to use.

(3) My strongest processing mechanism is the math logic.

It is counted as follows: "My weakest" in (1) and (2) equals four words because both words are repeated once. "processing mechanism is the" in (1) and (3) equals eight because all four of the words are repeated. The second occurrence of "processing mechanism" in (1) equals two because it is a repetition of a portion of the sequence "processing mechanism is the". The number of words contained in recurrent sequences equals 14. The total number of words equals 26. Thus, the percentage of speech comprised of recurrent sequences equals 53.85%.

The operational definition of recurrent sequences is very conservative because the purpose of the study is to determine whether recurrent sequences are fundamental building blocks underlying fluent speech production..

Research Questions

1. What proportion of nonnative English-speaker speeches consist of recurrent sequences?

2. Do the proportions of recurrent sequences vary across individuals?

3. Do the individuals' proportions of recurrent sequences vary across speech topics or retellings?

4. Are the subjects' self reported production strategies congruent with their use of prefabricated chunks of speech?

5. Do nonnative speakers use community-wide formulas or do they rely on idiosyncratic recurrent sequences?

Method

The study explores the use of recurrent sequences across a sample of nonnative English-speakers in the researcher's advanced speaking and listening class at the University of Hawaii, Manoa. In the language lab, participants were given a topic and told that they would have to prepare and later present a speech in class. They were instructed to prepare a three minute speech that they would record, listen to, edit, then re-record. This task was used by Arevart and Nation (1991) to observe the development of fluency in nonnative English-speakers and by Raupach (1984, 1987) to observe the use of phrases, and the development of fluency in advanced students of French. In this study, the repeated speech task was used because it is a naturalistic task in a real classroom setting that would heighten the external validity of the results.

To avoid the possibility of participants reading from a written script, they were only allowed to use a nine word outline. After ten minutes of preparation, they recorded their first attempts. They then listened to their tapes, edited their nine word outline, then recorded their second attempts. Over the next three class meetings, spanning two weeks, students gave their speeches in small groups and received feedback. Between 12 and 14 days later, we returned to the language lab where they re-recorded their speeches for a third time as final preparation for in-class presentations. This entire procedure was repeated for two more different topics over three months. The data from the first topic was excluded to remove the effects from their adjustment to being tape-recorded. The speech topics used for analysis are:

1. What are your strongest and weakest processing mechanisms among the kinesic, linguistic, inter-intrapersonal, math-logic, visual-spatial, or musical modes of processing? Give examples.
2. Have you adopted the American diet? In what ways does it vary from your native diet?

Topic one was unfamiliar to all of the participants. It was based on an academic lecture given in class describing Gardner's (1985) theory of multiple intelligences. Topic two was familiar to all of the participants because they had all conversed about changes in their diets on prior occaisons. Accordingly, comparisons between recurrent sequence production when addressing an unfamiliar topic could be compared to the familiar topic.

In addition to the tape recordings of the participants' speeches, students' written critiques of lectures were also collected to evaluate whether their use of written recurrent sequences was similar to their production of recurrent sequences when speaking. Also, student presentations on topics of their own choice were recorded both two weeks before their class presentations and during their formal presentations. The objective was to determine if their autonomous choice of topics would alter their use of recurrent sequences.

Additionally, the participants' self-reports describing their speech preparation strategies were elicited. These self-reports were collected in individual conferences with the researcher and by means of questionnaires. They introspected about their strategies for remembering what they wanted to say.

Furthermore, the subjects provided biographical information about their age, country of origin, careers, plans to remain in an English-speaking community, and their majors. They described prior English study, age of onset, lengthy stays in English-speaking countries and whether any of their family members were professional speakers. Finally, they provided information about their physical traits such as the age at which they began wearing glasses, and their handedness when performing certain activities.

Subjects

Twenty nonnative English speakers were enrolled in the advanced listening and speaking class. After the class was officially completed, the six students who completed every phase of the data collection process voluntarily agreed to be participants. The participant's names have been altered to maintain their anonymity. Their ages range from 18 to 37. Their native countries are Korea, Japan, Taiwan, Hong Kong, and the People's Republic of China.

Zoro, a 31 year old Ph.D., is a geophysics professor who had taught in China for three years. He had been researching and studying at the University of Hawaii for about one year at the time the data was collected. Of all of the students in the group, he has the lowest scores on the listening, writing, and dictation placement tests. Zoro reports having published widely in scientific journals in China.

Wookie is a 37 year old mother of two Korean children. She and her husband immigrated to Hawaii two years before the study to enhance their children's chances of obtaining a higher education. She has a B.A. in sociology and worked for an international corporation in Korea before coming to the U.S..

Peter is a thirty-year-old who taught junior high school in his native Taiwan before moving to the U.S. four years ago. While attending the University of Hawaii, he worked at Sea Life Marine Park. He was a performer in one of the seal shows. However, in order to be the performer who spoke to the audience, his supervisor told him that he had to improve his speaking skills. Otherwise, he had to remain in the tank.

Mickey is a 31 year old Ph.D. who taught journalism in the People's Republic of China. One and a half years ago he moved to Hawaii to study and conduct further research. He is a talented Chinese folk singer with a large repertoire committed to memory.

Jim is a 24 year old social worker from Japan. Even though he had just arrived in Hawaii at the beginning of the study, Jim had the highest placement tests of all of the participants. He is pursuing a Master's degree in sociology.

Cindy, is an 18 year old undergraduate student. She came from Hong Kong five years ago and attended high school in Hawaii. She has many Chinese speaking friends, and plans to return to Hong Kong after she finishes college.

Table 1

Personal Characteristics

SUBJECT	COUNTRY	NATIVE LANGUAGE	AGE	BEGAN STUDYING ENGLISH AT AGE	EFL STUDY (years)	TIME IN THE U.S. (years)	PROFESSION	HIGHEST DEGREE
ZORO	People's Republic of China	Chinese	31	18	4	1	Geophysics professor	Ph.D.
WOOKIE	Korea	Korean	37	12	10	2	International Business Administration	B.A. Sociology
PETER	Taiwan	Chinese	30	12	6	4	Junior High School teacher and Performer	B.A. Education
MICKEY	People's Republic of China	Chinese	31	10	10	1.5	Journalism Professor	Ph.D.
JIM	Japan	Japanese	24	12	7	.10	Social Worker	B.A. Sociology
CINDY	Hong Kong	Chinese	18	10	6	5	Student	High School

Results

All of the subjects did use recurrent sequences (RSs) extensively. After computing the number of words included in recurrent sequences and dividing by the total number of words, the percentages range from a low of 48.36% in

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Zoro's first telling of the diet speech (D) to a high of 80.22% in Cindy's second telling of the processing mechanism speech (P) (see Table 2).

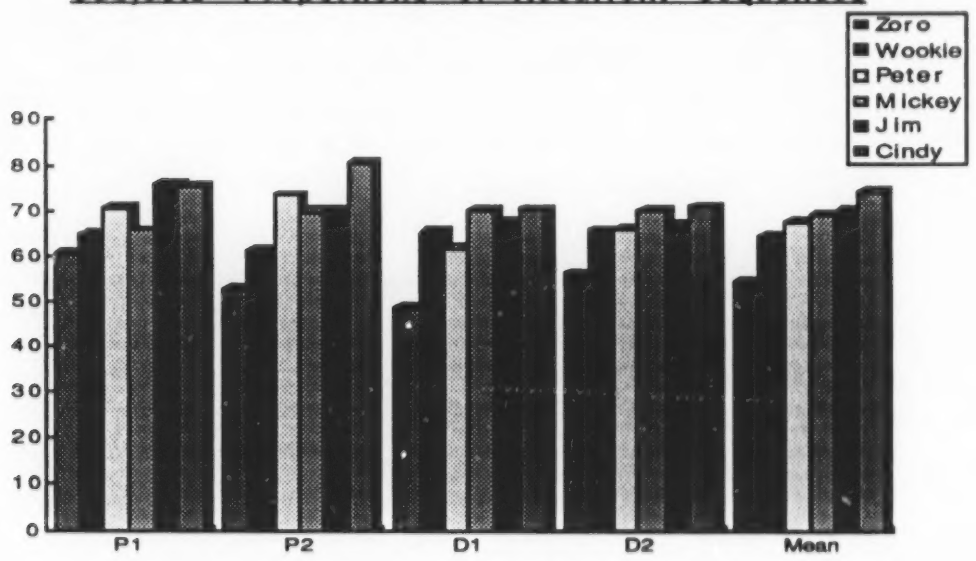
Table 2

Percentage of Speech Comprised of Recurrent Sequences and Rank

Subject	Processing P1	Speech P2	Diet D1	Speech D2	Subject's Mean	Subject's Range
CINDY	75.00 (2)	80.22 (1)	70.26 (1)	70.61 (1)	74.02% (1)	10%
JIM	75.50 (1)	69.74 (3)	67.16 (3)	66.56 (3)	69.74% (2)	9%
MICKEY	65.54 (4)	69.63 (4)	70.10 (2)	69.85 (2)	68.78% (3)	4%
PETER	70.35 (3)	73.37 (2)	61.26 (5)	65.62 (5)	67.40% (4)	12%
WOOKIE	64.68 (5)	61.02 (5)	65.01 (4)	65.52 (4)	64.06% (5)	5%
ZORO	60.40 (6)	52.76 (6)	48.36 (6)	56.00 (6)	54.38 % (6)	12%
Mean	68.58	67.79	63.69	65.53	66.40%	9%
Range	15.1	27.46	21.9	14.61	19.64%	8%

Figure 1

Subjects' Proportions of Recurrent Sequences



Upon examination of the percentages of the speeches comprised of RSs, there is relatively little individual variation among the subjects' percentages observed per telling. The mean is 65.53% with a standard deviation of 5.34. (See Figure 1 for a graph of the distribution.)

Each individual subject maintains a relatively constant percentage of RSs per topic. The Pearson correlation coefficient within topics is statistically significant ($p<.05$), equaling .85 for the processing speech and .99 for the diet speech. The subjects' percentages of RSs across topics is less consistent. The correlation between the percentages of RSs on the first tellings of the processing speech and the diet speech equals .65 (n.s.). The correlation between percentages on second tellings of the two speeches is significant however, $r=.84$ ($p<.05$). In short, the subjects tend to score very similarly relative to each other. For example, Zoro always uses the lowest percentage of RSs on all tellings and all topics. Cindy uses the highest percentage of RSs on all tellings and topics except the first telling of the processing speech, where she scores half a percent lower than Jim.

The participants do not demonstrate any consistent pattern in using greater percentages of RSs in the first or second telling, or across topics. Similarly, there are no consistent patterns between the percentages of RSs used and the participants' exposure to English or their physical characteristics. Likewise, no obvious relationships are observed between the participants' percentages of RSs and their professions, prior education, or having professional speakers in their immediate families. However, since so few speakers are analyzed in this study, it is premature to define this lack of correlations as conclusive.

Qualitative Differences

Although all of the participants use RSs extensively, they use RSs differently to arrive at high percentages of RSs. To further analyze the differences in the way subjects use RSs, four characteristics are scrutinized. The four characteristics which are further analyzed are: 1) the number of RSs that are immediately repeated, 2) the number of long RSs that are repeated, 3) the relationship between the length of the speeches and the percentages of RSs observed, and 4) the number of organizational sequences produced.

Immediate Repeats

Cindy and Peter tend to repeat their sequences immediately. Cindy shows 112 instances of RSs within three words of the exact same sequence of words. Peter uses immediate repetition 50 times. Both of these subjects exhibit this pattern far more often than the other subjects who range from 2 to 19 immediate repeats. In short, subjects vary widely in their use of immediate

repetitions of RSs. Some of the sequences that are repeated immediately by Cindy are:

First telling Processing Speech (P1):

when I	just like
when I hear	if they
when I say	they have different
when they feel	what they mean
when an instructor	know me
I really	I don't know
I really know	I don't know how to use the
is because	I really don't know how to

Table 3

Immediate Repeats

Subject	Immediate Repeats	Mean % of RSs
CINDY	112	74.0
PETER	50	67.4
JIM	19	69.7
ZORO	18	54.4
WOOKIE	8	64.1
MICKEY	2	68.8

Lengthy Sequences

Another aspect that varies widely across participants is their use of lengthy RSs. These are defined as exact repetitions of sequences longer than 6 words. Jim has the greatest number of lengthy sequences with 22, while both Cindy and Wookie use 18. Cindy has the two longest sequences. She repeats verbatim the following 18 word sequence in the first and second telling of her Diet Speech: "*like the last time I read the magazine, one scientist said egg is not good for your health.*" She also repeats the following 15 word sequence verbatim in the first and second telling of the diet speech: "*I'm Chinese. As many people know, Chinese always eat rice for their main food also.*"

Table 4

Lengthy Sequences

Subject	Number of RSs > 6 words	Number of RSs > 8 words	Number of RSs with 6-8 words	Mean % of RSs (rank)
JIM	22	4	18	69.74 (2)
CINDY	18	4	14	74.02 (1)
WOOKIE	18	6	12	64.06 (5)
ZORO	13	0	13	53.38 (6)
PETER	10	2	8	67.40 (4)
MICKEY	8	2	6	68.78 (3)

Table 4 reveals that the subjects vary in their tendency to repeat lengthy sequences. For instance, although Zoro consistently has the lowest proportion of RSs, he uses more lengthy sequences than both Peter and Mickey who have higher proportions of RSs than Zoro. On the other hand, Mickey uses very few lengthy sequences revealing his tendency to rely on short repeated sequences.

Speech Length

The number of words used did not correlate with the subjects' percentages of RSs. The Pearson correlation coefficient between the number of words in the speeches and the mean percentages of RSs equals .56 (n.s). The only subject who maintains her rank concerning length of speech, and percentage of RSs per telling and mean percentage of RSs is Cindy. She uses the greatest number of words and has the highest percentage of RSs per telling and overall.

The subjects' tendency to use a greater or lesser number of words is very consistent. The Pearson correlation coefficients for the number of words used per telling on each topic is .98 ($p<.01$). From Table 5 some individual patterns can be discovered. Mickey tends to use a greater percentage of RSs when compared to the number of words used. Wookie tends to use a smaller percentage of RSs when compared to the number of words spoken.

Table 5

Length of Speeches

Subject	Processing Speech		Diet Speech		Subject's Mean Range Per Topic	Subject's Total words	Subject Rank in RSs
	P1	P2	D1	D2			
CINDY	500 (1)	536 (1)	417 (1)	507 (1)	63	1960	1
JIM	400 (2)	390 (2)	268 (4)	323 (3)	33	1381	2
WOOKIE	218 (5)	254 (5)	375 (2)	435 (2)	48	1282	5
PETER	344 (3)	353 (3)	253 (5)	277 (4)	33	1227	4
MICKEY	267 (4)	270 (4)	204 (6)	199 (6)	8	940	3
ZORO	149 (6)	199 (6)	275 (3)	275 (5)	25	898	6
Range	351	337	213	308			

Organizational Sequences

In this study, an organizational sequence (OS) is defined as a sequence of words that denotes a topic shift such as the introduction of a supporting idea,

the introduction of a contrasting notion, a summary marker, an explanatory marker, a beginning marker, or a conclusion marker. To quantify the number of OSs contained in speeches, the researcher and an independent rater each went through the transcripts of the speeches independently and made a list of all of the OSs. After comparing the lists, 6% of the sequences were eliminated because they were not found on both lists. Similarly, both raters listed all of the OSs found in five written essays by the subjects. From those lists, 5% of the sequences listed were eliminated because they were not found on both raters' lists. The number of OSs equals the OSs found on both raters' lists for written and spoken data.

Some examples of Wookie's spoken OSs are:

And the first question is
First of all
The first
The second
That's why
For the morning

Today we are going to talk about the
I'm about to talk about
So, that means
So, I'm
So, even though
Even though the

And also
In other words
In conclusion
In summary

Table 6

Organizational Sequences

SUBJECT	SPOKEN				WRITTEN
	OS Tokens	OS Repeated	OS Not Repeated	Different OSs	OS Tokens
WOOKIE	60	43	17	34	13
JIM	55	39	16	30	30
MICKEY	44	33	11	24	13
CINDY	42	35	7	20	8
PETER	42	34	8	19	16
ZORO	31	27	4	15	16

It is noteworthy that most of the OSs for each subject are repeated. Zoro repeats 27 out of 31 (87%). Cindy repeats 35 out of 42 (83%). Peter repeats 34 out of 42 (81%). Mickey repeats 33 out of 44 (75%). Wookie repeats 43 out of 60 (72%). Jim repeats 39 out of 55 (71%). In sum, all of the subjects use OSs and all of them repeat more than 70% of the OSs employed. Furthermore, it is important to remember that these instances of OS were not identified on the basis that they were repeated sequences but instead, the raters combed the transcripts looking for OSs that fulfilled the functional definition. There is no significant correlation between the number of OSs used in written essays and oral speeches.

Individual Differences

Table 7 sets forth how the subjects reported their strategies for preparing speeches. They reported a fair degree of awareness about how the words fall into place for them as they speak. The subjects' introspections reveal that each of the subjects perceive the speech task differently. Jim, Zoro, and Wookie approach the task as a problem solving organizationally based task. For example, Jim reports that he organizes his ideas into a big map. He concentrates on organization and chooses appropriate connectors. In fact, Jim's, Wookie's, and Zoro's RSs reveal their emphasis on organization. Jim and Wookie use the greatest number of Organizational Sequences. Even Zoro who uses the least number of RSs uses the third highest number of Organizational Sequences. In other words, the participants' approach to the task as an organizational problem solving activity is reflected in their use of Organizational Sequences.

On the other hand, Cindy, Mickey and Peter approach the task as a performance. For instance, Cindy prepares as if she were preparing to play a piano piece. Mickey compares his speech preparation to memorizing Chinese folk songs. Peter also emphasizes smoothing out snags in his delivery by practicing out loud. Once again, these subjects' performance based approach is revealed by the types of RSs they use. Cindy's RSs tend to be lengthy. Mickey demonstrates his dependence on RSs by using the same RSs not just across tellings, but, across topics. Finally, Peter, not only relies on RSs extensively, but he maintains the same intonation and prosody across tellings revealing his performance based approach. In short, depending on how the subjects framed the task, as a problem solving activity or as a performance activity, correlates with the types of RSs they use to achieve their goals.

Equally important, when the subjects report how the words come to mind, none of them ever report that syllables, morphemes or inflections are pieced together. Instead, they report that upon the first telling either pieces of phrases, whole phrases, or strings of phrases come to mind. Furthermore, on subsequent tellings, all of the subjects reveal that small phrases, or series of phrases emerge as preassembled sequences.

Table 7

Subjects' Introspections and Characteristics of Their RSs

Subject	Speech Preparation Techniques	Acquisition Techniques	How words come to mind	Length of Preassembled Chunks	RS Characteristics
CINDY	Practice until it is smooth like playing the piano.	I watch TV to see how others speak. Recite speech in front of others and ask for suggestions.	Pieces of clauses. I have difficulties remembering what idea comes next.	A few words or a small phrase, sometimes I can link phrases together, but they do not come to mind before they are joined.	Pervasive Immediate Repetition; Many Lengthy Sequences. Strings together previously used phrases. Changes content across retellings.
JIM	Visualize. Organize ideas into a big map. Concentrate on organization first. Develop the main ideas then the supporting points. Choose appropriate transitions and phrases. Practice.	I practice a little each day to speak smoothly, decrease pauses, improve pronunciation control, volume, and speed.	On the first run through, phrases or portions of phrases at a time. On subsequent retellings, I can hear entire strings of phrases before I say them.	Upon retelling a speech, strings of phrases re-emerge effortlessly.	Many OSs. Repeats Lengthy Sequences. Consistent subject matter and organization across re-tellings.
MICKEY	I remember how I put the words together on prior practice attempts so I can correct the organization of them when I do it again.	I pick up phrases from TV, and movies. I practice these phrases. It's like memorizing Chinese folk songs.	I hear an entire phrase before I say it.	Entire phrase or series of phrases which have been used together on a prior occasion	Uses short RSs both within and across topics.

Table 7 (Continued)

Subjects' Introspections and Characteristics of Their RSs

Subject	Speech Preparation Techniques	Acquisition Techniques	How words come to mind	Length of Preassembled Chunks	RS Characteristics
PETER	Focus on the main idea then use supporting details. Practice out loud. When I hit a snag, I practice and smooth that part out.	I Converse with NSs including my girlfriend. I try to imitate phrases.	Phrase by phrase or strings of phrases	Upon the first telling, entire phrases. Subsequent tellings, strings of phrases.	Uses short RSs. Many Immediate Repeats. Adopts the phrasing and prosody of NSs. Keeps subject matter constant in re-tellings.
WOOKIE	I must write ideas down, reorganize on paper then practice from written notes.	I learn new phrases from social interaction with NSs and TV news.	Fragments of phrases. Even if corrected on a prior occasion, I can't recall the correct way to phrase the idea.	Small phrases	Many different OSs and short RSs. She only repeats portions of previously used phrases. Changes content across retellings.
ZORO	I focus on organization. First, broad ideas then supporting details.	I listen to others discussing topics. Pick up key phrases for use in my lectures or scholarly papers.	Concept by concept, idea by idea.	Phrases	Most of his RSs are OSs. Maintains coherence by inserting OSs. Uses Lengthy RSs.

Discussion of Research Questions

1. What proportion of nonnative English-speakers' speeches consist of recurrent sequences?

Across all topics and all tellings the proportion of recurrent sequences range from 48.36% to 80.22%. The mean proportion of recurrent sequences across subjects is 66.40%. The finding that over two-thirds of the speeches are

comprised of recurrent sequences supports the neural network and semantic network models of fluent speech production. However, one issue that Instance Theory does not adequately address is that the subjects' recurrent sequences overlap. For example, in Wookie's transcript the following utterances are found:

1) My weakest (processing mechanism is linguistic)

2) (That is my strongest processing mechanism)

3) Friends say that is my strongest processing mechanism is linguistic

When one analyzes utterance (3) , there are overlaps with both (1) and (2). Nowhere else does Wookie repeat any of these three utterances in their entirety as predicted by the Instance Theory.

The high proportion of recurrent sequences can be explained by the Strength Theories. The overlap issue is not a problem for the Strength Theories because subjects are expected to assemble situation-sensitive schema from knowledge fragments. The finding that is not reconcilable with the Strength Theories is that the subjects do not use more recurrent sequences in subsequent tellings than in the first tellings of their speeches. According to the Strength Theories, the subjects should have developed interconnected networks upon their first tellings and should have been able to use these networks more widely upon retellings. However, the data reveal that the participants vary in their percentage of recurrent sequences between tellings without any regular pattern.

Table 8

Changes in Percentages of RSs Across Tellings

Subject	Change from First Telling to Second Telling of the Processing Speech	Change from First Telling to Second Telling of the Diet Speech	Mean % of RSs and (Rank)
Cindy	5.22%	.35%	74.02 % (1)
Jim	-5.76%	-.60%	69.74% (2)
Wookie	-3.66%	.51%	68.78% (3)
Peter	3.02%	3.36%	67.40% (4)
Mickey	4.09%	-.25%	64.06% (5)
Zoro	-7.64%	7.64%	54.38% (6)

Strength Theories predict that the subjects would use more recurrent sequences on second tellings. However, the data do not support this prediction.

Finally, semantic network theories such as Hierarchical Chunking Theory (HCT) appears to account for the subjects' extensive use of recurrent sequences. The Hierarchical Chunking Theory model hypothesizes that the speakers are relying on recurrent sequences stored simultaneously as short phrases, phrases with slots, and lengthy sequences. Hierarchical Chunking Theory can account for the prevalence of recurrent sequences that only partially overlap and the finding that participants do not use more recurrent sequences in subsequent tellings of their speeches than on earlier tellings.

The subjects use recurrent sequences flexibly. For example, they may join two or more recurrent sequences into a lengthy sequence called fusion by Peters (1983). Alternatively, they may break up lengthy sequences and use only a portion of the prior recurrent sequence. Peters (1983) labeled this phenomena as fission. Also, they may substitute one portion of a recurrent sequence with a new word or phrase. This is described as frame and slot construction by Peters (1983). For example, despite the fact that between 61% and 65% of Wookie's speeches are comprised of RSs, rarely does she repeat an entire phrase word for word. For example, Wookie produces the following variations:

There are some people
There are several people
For a long time
For quite a long time
Too much oil
Too much calorie
She always would
I always would like to
I'm always trying to
We always take
She like pizza or hamburgers
Say about pizza or hamburgers
During the meal
Between the meal
Try to prevent
Try to control
Try to reduce

It's a bit difficult
That's a bit difficult
We had a lot of soda
We had a lot of garlic and pepper
We had a lot of spices
We had a lot of people
We had a lot of friends
We had a lot of foods
Typical American style
Typical Korean style
Typical Korean style lunch
Typical American style lunches
Typical Korean style dinner
I don't like the processed food
I don't like that
I don't like the soda
I cannot catch what
I cannot have a picture

In essence, since Hierarchical Chunking Theory predicts that the units of production are flexible prefabricated sequences, they can be modified by the speaker to meet his or her immediate communicative needs

2. Do the proportions of recurrent sequences vary across individuals?

The range of the subjects' mean percentages of RSs equals 20.36%, with a high of 74.02% and a low of 54.38%. (See Table 2 and Figure 1.) The percentage of RSs on each of the four tellings range across subjects as follows: 15% on the first telling of the Processing speech, 28% on the second telling of the Processing speech, 22% on the first telling of the Diet speech, and 15% on the second telling of the Diet speech. Hence, if one measures the percentages of RSs observed, it appears that the proportion of RSs production does vary across subjects, but not dramatically. The implication of this finding is that most individuals may rely on recurrent sequences to produce fluent speech.

3. Do the individuals' proportions of recurrent sequences vary across speech topics or retellings?

Table 9

Variation in Percentages of RSs Across Topics and Tellings

Subject	Variation of RSs Across Topics	Variation of RSs Across Tellings
CINDY	7.2%	2.79%
JIM	5.8%	3.18%
MICKEY	2.4%	2.09%
PETER	8.9%	3.19%
WOOKIE	2.4%	2.17%
ZORO	4.4%	7.64%
Mean	5.2%	3.51%

Each individual subject's variation in percentage of RSs across topics is small with a mean of 5.2%. Each individual's variation across tellings on the same topic is also very small with a mean of 3.51%. The variation within subjects across topics and tellings is much smaller than the mean variation across subjects which equals 19.64%. To recapitulate, the individual subjects' recurrent sequence production varies across topics and retellings, but, compared to the variation between subjects, the variation across topics and retellings is far smaller.

Each subject tends to use the same percentage of recurrent sequences regardless of the topic. These results are important because the processing speech dealt with an unfamiliar topic. In sharp distinction, all of the subjects reported that they had discussed the difference between their native diet and the American diet. This result suggests that these findings are valid for both familiar and unfamiliar topics. In short, the subjects tend to maintain their percentage of recurrent sequences regardless of their familiarity with the topic.

4. Are the subjects' self reported production strategies congruent with their use of recurrent sequences?

The subjects report different production strategies. Three of the subjects, Jim, Zoro, and Wookie perceive the task as a problem solving activity. Accordingly, they allocate a great deal of their cognitive capacity toward maintaining a specific organization. Their primary concern while speaking is that they remember what idea to discuss next.

In contradistinction, Cindy, Mickey, and Peter perceive the task as being similar to learning a script or musical piece. Their primary concern while speaking is not what they would say next, but, how smoothly they would perform their speeches.

This contrast is illustrated by how they use recurrent sequences. For example, Zoro who had taught geophysics in China for a number of years was concerned about employing appropriate organizational structures in his speeches. He reports trying to maintain an overall organization when speaking. The data support his self reported focus on organization. The majority of his RSs are organizational. For instance, Zoro strategically used the following RSs:

In fact	(support)
On the other hand	(contrast)
This means	(explanation)
In other words	(explanation)
And, the second	(topic shift)
And the third	(topic shift)
In conclusion	(conclusion marker)
That's all	(end marker)

Similarly, both Wookie and Jim use the highest number of organizational sequences among the subjects supporting their self reported focus on organization. (See Table 6.)

Meanwhile, Cindy, Mickey, and Peter do not stress organization. In fact, Cindy reveals this in a portion of her Processing Speech. The line breaks reflect pauses in Cindy's delivery.

um
I
for myself
I never organize
the
thing that I want to say
um
I
have no organization at all
so
I always
talk to people like
come to the
the conclusions first
then I go back to the introduction
then
talk to the conclusion
then I come to the main point
then go back to the topic
and then talk to everything else
and topic to talk back

In essence, Cindy's lack of organization and her awareness of her deficit are apparent in both her transcripts and her self reports. Although she recognizes her organizational deficits, she as the only undergraduate in the study may not have the organizational skills which the other graduate students posses. Instead, she has developed compensatory uses of RSs to maintain fluency. First, she uses immediate repetitions. No other subject even comes close to using 112 immediate repeats which her transcripts contain. (See Table 3.) Peter has the second greatest number of immediate repeats with 50, followed by Jim with 19, Zoro with 18, Wookie with 8, and Mickey with 2. Second, she uses the greatest number of lengthy RSs.

Similarly, Peter reports that his strategy for preparing speeches is similar to memorizing a script. For example, when he delivers a speech about seals, many of the phrases in his speech are exact repetitions of the narrator on the Sea Life Park video tape. He even adopts the narrator's intonation and prosody. Peter reports that his first attempts at practicing a speech are disjointed. However, with practice, he reports that long strings of phrases are repeated word for word allowing his ideas to flow smoothly.

Finally, Mickey, a journalism professor from China, is a talented Chinese folk singer. He reports relying on certain utterances that he can use in many

different contexts. In fact, he repeats sequences of eight words or more not only in repeated speeches about the same topic, but in speeches addressing different topics. Interestingly, Mickey reports that when he practices, he hears a phrase before he says it, especially on subsequent retellings.

Overall, the subjects have a fair degree of awareness of their strategies for preparing speeches. They all report acquiring phrases in conversation and from TV viewing. They try to acquire entire collocations, not just single words. Equally important, when it comes to producing their own speeches, all of the subjects report that pieces of phrases, entire phrases, or strings of phrases come to mind. This is supported by the data that most of the subjects' speeches are comprised of recurrent sequences. Furthermore, all of the subjects except for Wookie report that once their phrasing has been corrected, the corrected phrase comes to mind on subsequent occasions.

The implication of the subjects' awareness of their preparation strategies and their reliance on recurrent sequences is that ESL students would benefit from English for Special Purposes classes. These courses would help them develop recurrent sequences associated with their academic disciplines.

5. Do nonnative speakers use community-wide formulas or do they rely on idiosyncratic recurrent sequences?

The subjects almost exclusively rely on idiosyncratic recurrent sequences. By reviewing the list of RSs observed, the raters could not agree that any of the sequences were community-wide formulas. Even when a subject appeared to be trying to adopt a native collocation, he or she transformed it into his or her own idiosyncratic version. For example, the subjects use the following idiosyncratic recurrent sequences as opposed to using native-like phrases:

Wookie:	I don't think the sweetness is not good for health.
Wookie:	My first daughter has been suffered
Peter:	eat one kind of the food in each meal
Cindy:	the American, they are really care about the calorie
Mickey:	I'm learning how to communicate each other and how to master
Mickey:	I gradually adapted to eat American diet
Zoro:	Always to the fast food restaurant like the McDonald
Zoro:	it really not too much.

Although the speakers approximate native-like collocations, they only use idiosyncratic versions. No community-wide idioms were observed. Thus, if researchers wish to study the role of recurrent sequences in nonnative English-

speaker production, they must not restrict their definitions to native formulas as did Bolinger (1976, 1977) and Gibbs (1980), or they are likely to overlook the central finding that nonnative English-speakers do rely on recurrent sequences, more specifically idiosyncratic recurrent sequences.

Moreover, by studying nonnative English-speakers, one is able to detect whether the phrases are a result of syntactic rule-based production or memory-based phrase retrieval. In the case of nonnative English-speakers, they use recurrent sequences that do not conform to syntax rules. Consequently, their use of idiosyncratic sequences allows us to tease apart the importance of recurrent sequences as opposed to syntax for fluent speech production.

Conclusion

The data support the flexible use of neural and semantic networks to produce fluent speech. First, the subjects do not repeat the exact same utterances. Most of the recurrent sequences overlap with prior instances but are not identical as would be predicted by Instance Theory. Second, the subjects demonstrate consistent proportions of recurrent sequences across retellings and topics. Hierarchical Chunking Theory predicts that recurrent sequences can be stored as smaller and lengthier sequences with slots to customize utterances for the speaker's immediate needs. Hence, Hierarchical Chunking Theory is flexible enough to accommodate the data where nonnative speakers repeat exact instances, they break apart longer sequences into shorter sequences, join shorter sequencess into lengthy sequences, and use overlapping recurrent sequences.

At the same time, Hierarchical Chunking Theory is supported from a socioconstructive psycholinguistic perspective. The reason the speakers adopt this style of production is because they want their listeners to be able to parse the speech stream and comprehend the message. If the speaker and listener share a common hierarchical chunking process both to produce and comprehend speech, they can rely on this unitary processing mechanism for both listening and speaking.

Of course this analysis of several nonnative speakers only provides an inkling of the processes underlying fluent speech production. The information discussed here is only suggestive. Nonetheless, the data does support the notion that fluent speech can be achieved by using a hierarchical network of of

recurrent sequences. Thus the use of recurrent sequences should not be ignored.

This raises an important pedagogical concern. Currently, one of the popular notions in teaching ESL is that error correction is a waste of time. The theory behind this viewpoint is based on a grammatical structure acquisitional hierarchy (e.g. Meisel, Clahsen & Piennemann, 1981). The Acquisitional Hierarchy Theory holds that certain grammatical structures cannot be mastered before other structures. Therefore, one should not waste time trying to correct grammatical structures that a student is not ready to acquire. However, if fluent speech production is based on recurrent sequences, then avoiding error correction may be doing learners a disservice.

In light of the introspective data in this study, all but one of the subjects report that upon retelling a speech, their phrases or strings of phrases reemerge effortlessly. They also report being able to produce corrected phrases effortlessly on subsequent retellings. Thus, correction combined with practice of the corrected recurrent sequences, may be very helpful. The ability to use prefabricated sequences without conscious effort appears to be a fruitful capability ready to be explored and exploited for the benefit of nonnative speakers. Furthermore, if fluent speech production depends on a hierarchical network of prefabricated chunks, it would be important to allow ESL students to study English for special purposes to learn the common collocations associated with their academic disciplines.

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